and foundry engineering demands narrowed the search to a separate stream treatment concept. Some progress was made in a method that holds promise. An interesting and useful technique to observe molten metal-alloy reactions by high speed color photography was used. Additional work is indicated.

Granular or chunk alloy dissolved very rapidly in a stream of iron: apparently in less than five sec under the test conditions, which were moderate flow rates through a rectangular chamber. The flow rates ranged from 5 to 10 lb per sec and 12 to 30 in. per sec linear velocity at pouring temperatures of 1343 to 1438C (2450F to 2620F). Accordingly, compacts of 5% elemental magnesium in iron, impregnated with polyester resin, were used. The resin-impregnated compacts reacted very slowly and at 5% Mg did not adequately treat the iron. A considerable portion of the alloy remained undissolved. This was contrary to earlier results where alloys had dissolved very rapidly.

Granular alloy was then placed in a shallow angular depression in the bottom of a runner. The alloy completely dissolved and nodularity was achieved over a 13-sec pouring span. A dry sand photographic model was assembled and the flow of iron over the alloy photographed at 200 frames per sec. The solution proceeded steadily and quietly with what seemed relatively little vapor generation. The exit of the metal stream was to open air 8 in. downstream from the alloy. The runner was 2 in. wide by ¾ in. deep. This model was repeated several times with alternately 15% Mg-Ni crushed alloy and 8% magensium ferrosilicon crushed alloy. Solutions proceeded quietly in all tests. The solution rate appeared to decrease as the level of alloy was progressively lowered.

A second photographic model was assembled, similar to the first except that the alloy chamber was 3 by 3 in. by 4 in. deep. There was considerable turbulence and significantly more vapor generation. With the deep rectangular chamber and 8% magnesium ferrosilicon alloy, iron at 1349C (2460F) was poured at a velocity of 13 in. per sec and sampled from the exit stream 5 sec apart. The first sample had few nodules, degenerate and vermicular graphite with 2.78% Si and 0.030% Mg. The second sample had 3.39% Si and 0.62% Mg with spheriodal, exploded and degenerate graphite and dross. The base silicon was 2.03 with 0.031 %S.

After testing a 3rd model, a 2000 lb treatment was next attempted. Pouring blocks used in the previous trials were modified to quadruple the pouring rate. The runner cross section was enlarged from 2 in. width by ¾ in. height to 4 in. width by 1½ in. height. Only 1700 lb were treated. The quantity of alloy was an intended overtreatment at 12 lb of 15% Mg-Ni alloy. The treated iron was collected in a ladle. Base iron was 1427 C (2600F) with 3.76%C, 1.98% Si and 0.030% S. Samples taken from the treated iron showed spheroidal graphite with 0.057% Mg. This was low efficiency of recovery, about 55 per cent. There was also considerable fume.

Below 1427C (2600F) efficiency of stream treatment seems to be very good. But above 1428C (2700 F), more vapor is evolved and the reaction time is short; also, magnesium recovery is low. The stream treatment technique, while not yet perfected, has promise.

Applications of Boron Radiography by J. D. Garnish and J. D. H. Hughes, *Journ. Inst. of Metals*, Vol. 101, 1973, p. 108-111—This article may be of interest to metalcasters who have a problem with calcium boride deoxidizer in copper, with titanuim boride as a grain refiner in aluminum or with boron distribution in cast steels or malleable irons. It would also serve where boron was suspected as part of an inclusion such as hard spots in maganese bronze. The technique is simple, however it requires access to a source of thermal neutrons like a nuclear reactor.

In practice, some plastics can record the passage of low-energy alpha particles while remaining unaffected by comparatively high doses of thermal neutrons and gamma radiation. This enables detection of the ^{10}B isotope, which is present in amounts up to 19% in natural boron. Therefore, if a metal sample has any natural boron, it is not necessary to dope it with radioactive materials. The exposed polymer film is etched in KOH solution, revealing the presence of boron and areas of its concentration. While oxygen, sulfur and lithium also will register on plastic, such high concentrations of their isotopes are needed that they do not interfere with the test for boron, which is sensitive to one part per million.

Boron in steel concentrates at the grain boundaries in the form of iron-chromium borocarbides; these autoradiograph to show how carbides are distributed between grains. This technique also permits study of the way in which carbon and nitrogen affect boron solubility, especially in cast stainless steels and in malleable irons. *(courtesy J. Edwards).*

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